PB-239 643

ALBERT LEA LAKE, FREEBORN COUNTY, MINNESOTA

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
Minnesota National Guard
Minnesota Pollution Control Agency

October 1974

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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REPORT

ON

ALBERT LEA LAKE

FREEBORN COUNTY

MINNESOTA

EPA REGION V

WORKING PAPER No. 80

WITH THE COOPERATION OF THE

MINNESOTA POLLUTION CONTROL AGENCY

AND THE

MINNESOTA NATIONAL GUARD

OCTOBER, 1974

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Minnesota Pollution Control Agency for professional involvement and to the Minnesota National Guard for conducting the tributary sampling phase of the Survey.

Grant J. Merritt, Director of the Minnesota Pollution Control Agency, John F. McGuire, Chief, and Joel G. Schilling, Biologist, of the Section of Surface and Groundwater, Division of Water Quality, provided invaluable lake documentation and counsel during the course of the Survey; and the staff of the Section of Municipal Works, Division of Water Quality, were most helpful in identifying point sources and soliciting municipal participation in the Survey.

Major General Chester J. Moeglein, the Adjutant General of Minnesota, and Project Officer Major Adrian Beltrand, who directed the volunteer efforts of the Minnesota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

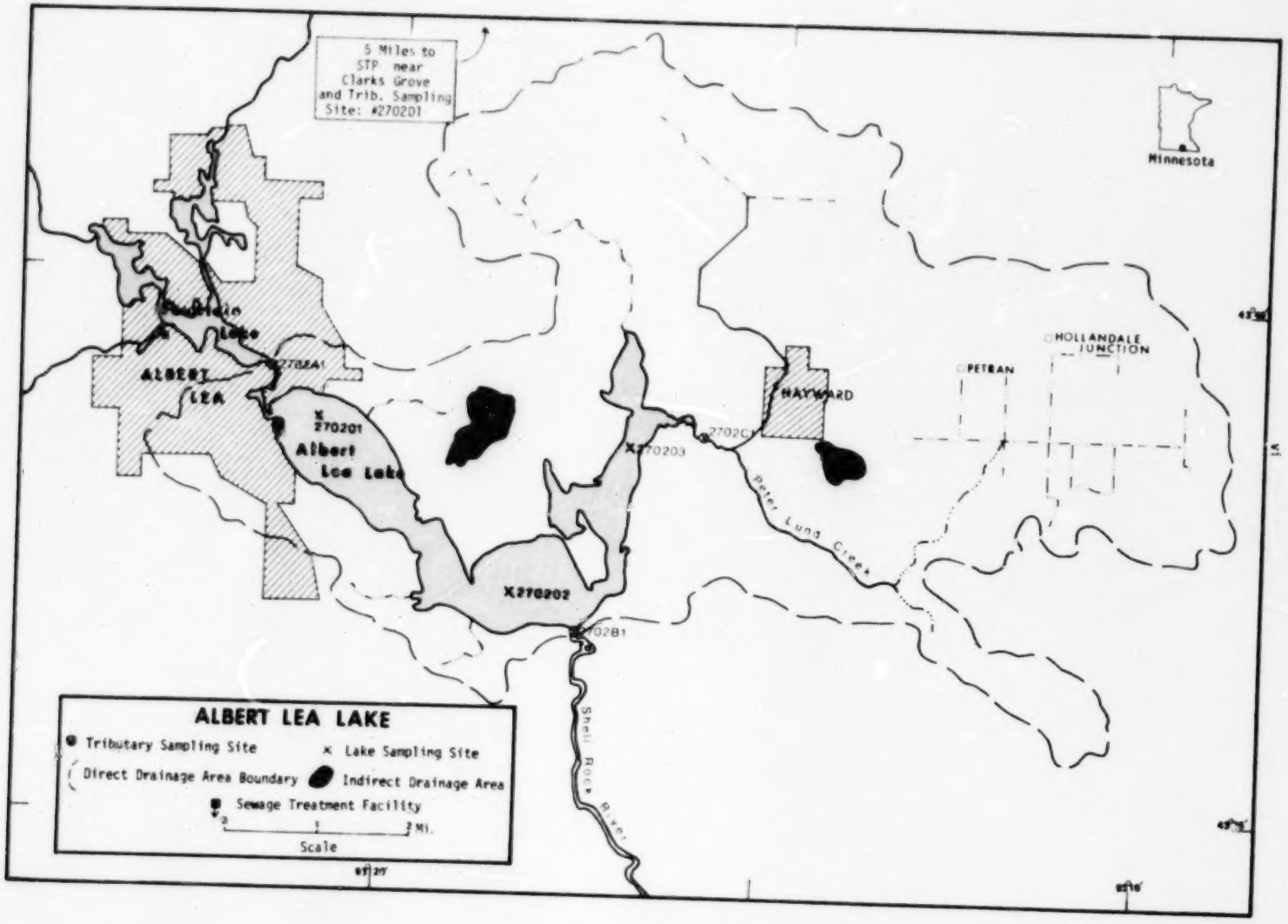
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MINNESOTA

LAKE NAME	COUNTY
Albert Lea	Freeborn
Andrusia	Beltrami
Badger	Polk
Bartlett	Koochiching
Bear	Freeborn
Bemidji	Beltrami
Big	Stearns
Big Stone	Big Stone, MN; Roberts, Grant, SD
Birch	Cass
Blackduck	Beltrami
Blackhoof	Crow Wing
Budd	Martin
Buffalo	Wright
Calhoun	Hennepin
Carlos	Douglas
Carrigan	Wright
Cass	Beltrami, Cass
Clearwater	Wright, Stearns
Cokato	Wright
Cranberry	Crow Wing
Darling	Douglas
Elbow	St. Louis
Embarass	St. Louis
Fall	Lake
Forest	Washington
Green	Kandiyohi
Gull	Cass
Heron	Jackson
Leech	Cass
Le Homme Dieu	Douglas
Lily	Blue Earth
Little	Grant
Lost	St. Louis

LAKE NAME	COUNTY
Madison	Blue Earth
Malmedal	Pope
Mashkenode	St. Louis
McQuade	St. Louis
Minnetonka	Hennepin
Minnewaska	Pope
Mud	Itasca
Nest	Kandiyohi
Pelican	St. Louis
Pepin	Goodhue, Wabasha, MN; Pierce, Pepin, WI
Rabbit	Crow Wing
Sakatah	Le Sueur
Shagawa	St. Louis
Silver	McLeod
Six Mile	St. Louis
Spring	Washington, Dakota
St. Croix	Washington, MN; St. Croix, Pierce, WI
St. Louis Bay	St. Louis, MN; Douglas, WI
Superior Bay	St. Louis, MN; Douglas, WI
Swan	Itasca
Trace	Todd
Trout	Itasca
Wagonga	Kandiyohi
Wallmark	Chisago
White Bear	Washington
Winona	Douglas
Wolf	Beltrami, Hubbard
Woodcock	Kandiyohi
Zumbro	Olmstead, Wabasha


5 Miles to STP near Clarks Grove and Trib. Sampling Site: #270201
Minnesota
Albert Lea Lake
270201
Albert Lea Lake
HOLLANDALE JUNCTION
PETRAN
HAYWARD
270203
Peters Lund Creek
270202
Shell Rock River
ALBERT LEA LAKE
Tributary Sampling Site
Lake Sampling Site
Direct Drainage Area Boundary
Indirect Drainage Area
Sewage Treatment Facility
2 Mi.
Scale

ALBERT LEA LAKE

STORET NO. 2702

I. CONCLUSIONS

A. Trophic Condition:

Survey data and the records of others show that Albert Lea Lake is highly eutrophic.

B. Rate-Limiting Nutrient:

The algal assay results are considered unreliable because of a significant loss of nutrients. However, the lake data show that Albert Lea Lake was nitrogen limited at all sampling times.

C. Nutrient Controllability:

1. Point sources--During the sampling year, it is estimated that Albert Lea Lake received a total phosphorus load at a rate about 14 times that proposed by Vollenweider (in press) as "dangerous"; i.e., a eutrophic rate (see page 15). Of that load, the City of Albert Lea, Wilson & Company, and the Village of Clarks Grove collectively contributed about 84% (one-half of the Clarks Grove load is assumed to have been sedimented and/or biologically assimilated in Fountain Lake).

In the following table, the total phosphorus loading rates that can be achieved by specified levels of phosphorus removal at all three point sources are shown and compared to Vollenweider's suggested rates.

% P Removal	Total P Loading lbs/acre/yr	Total P Loading $g/m^2/yr$
Existing	56.3	6.31
50	32.7	3.67
70	23.3	2.61
80	18.6	2.08
90	13.9	1.56
100	9.2	1.03

Vollenweider:	
Eutrophic rate	0.44
Oligotrophic rate	0.22

It will be noted that none of the above removal options would reduce the phosphorus loading rate to an optimal level. However, it is believed that a relatively high level of phosphorus removal at the indicated point sources would result in a significant reduction in the incidence and severity of nuisance algal blooms in Albert Lea Lake, but it would be expected that rooted aquatic vegetation would continue to be a problem because of the alternate source of nutrients in the sediments and the shallowness of the lake. The dredging program at the lake should relieve the weed problem in time.

It is noted that the Minnesota Pollution Control Agency has stipulated that phosphorus reduction be instituted at the City of Albert Lea wastewater treatment plant and that ammonia reduction shall be initiated conditional upon completion of bioassay studies to determine if existing levels are toxic; the

Agency has provided funding to the City for Step I preliminary plans (McGuire, 1974).

2. Non-point sources--It is calculated that non-point sources contributed only about 16% of the total phosphorus load to Albert Lea Lake during the sampling year. However, the nutrient exports of Peter Lund Creek were quite high as compared to the exports of Minnesota streams studied elsewhere (see page 15); it is not known whether these exports reflect the intensive agriculture in the area or resulted from other unmeasured sources.

II. INTRODUCTION

Albert Lea Lake, Freeborn County, is a large but shallow natural lake in the Cedar River (Iowa) drainage basin and is the headwaters of the Shell Rock River, an interstate stream.

Freeborn County is located in southeastern Minnesota and borders on the State of Iowa. The productive soil in the county supports intensive agricultural uses, mainly the growing of field crops and vegetables.

Recreational uses of the lake are largely limited to boating, swimming, and camping. A large State park and an organizational campground are located on the shoreline.

The Minnesota Department of Natural Resources manages the lake as a waterfowl-game lake; the shallow depth and recurring oxygen depletion prevent the establishment of a fishery.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry*:

1. Surface area: 2,453 acres.
2. Mean depth: 3.5 feet.
3. Maximum depth: 6 feet.
4. Volume: 8,586 acre/feet.
5. Mean hydraulic retention time: 73 days.

B. Tributary and Outlet:
(See Appendix A for flow data)

1. Tributaries -

Name	Drainage area†	Mean flow†
Fountain Lake Outlet	99.2 mi^2	39.8 cfs
Peter Lund Creek	29.2 mi^2	12.5 cfs
Minor tributaries & immediate drainage -	15.2 mi^2	7.0 cfs
Totals	143.6 mi^2	59.3 cfs

2. Outlet -

Shell Rock River	147.4 mi^2††	59.3 cfs††

C. Precipitation†††:

1. Year of sampling: 42.4 inches.
2. Mean annual: 28.7 inches.

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* DNR lake survey map (1964).
† Drainage areas are accurate within ±5%; mean daily flows are accurate within ±10%; and ungaged flows are accurate within ±10 to 25% for drainage areas greater than 10 mi^2.
†† Includes area of lake; outflow adjusted to equal sum of inflows.
††† See Working Paper No 1, "Survey Methods".

IV. LAKE WATER QUALITY SUMMARY

Albert Lea Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the lake (see map, page vi). During each visit, a single sample was composited from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon sample was composited from the three stations for algal assays. Also each time, a sample was collected from each of the stations for chlorophyll *a* analysis. Because of lack of depth, only near-surface samples were collected.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake was essentially well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

		FALL VALUES (10/29/72)		
Parameter	Minimum	Mean	Median	Maximum
Temperature (Cent.)	7.5	7.7	7.8	7.8
Dissolved oxygen (mg/l)	11.1	14.0	14.0	17.0
Conductivity (μmhos)	725	767	750	825
pH (units)	8.4	8.5	8.5	8.5
Alkalinity (mg/l)	200	215	208	238
Total P (mg/l)	0.363	1.274	1.380	2.080
Dissolved P (mg/l)	0.048	0.936	1.060	1.700
NO_2 + NO_3 (mg/l)	0.660	3.210	0.670	8.300
Ammonia (mg/l)	0.140	0.970	0.170	2.600
		ALL VALUES		
Secchi disc (inches)	3	7	6	12

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
07/01/72	1. Oscillatoria	44,727
	2. Scenedesmus	12,727
	3. Merismopedia	5,091
	4. Microcystis	3,818
	5. Aphanocapsa	3,455
	Other genera	7,818
	Total	77,636
08/30/72	1. Oscillatoria	39,053
	2. Microcystis	25,312
	3. Lyngbya	16,274
	4. Merismopedia	11,571
	5. Anabaena	10,848
	Other genera	65,088
	Total	168,146
10/29/72	1. Cyclotella	22,406
	2. Oscillatoria	6,241
	3. Flagellates	4,511
	4. Fragilaria	4,361
	5. Scenedesmus	3,684
	Other genera	11,203
	Total	52,406

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
07/01/72	01	478.4
	02	513.1
	03	452.1
08/30/72	01	510.2
	02	245.6
	03	756.0
10/29/72	01	177.3
	02	145.5
	03	152.6

C. Limiting Nutrient Study:

There was a significant loss of nutrients in the assay sample between the time of collection and the beginning of the algal assay, particularly inorganic nitrogen (the ammonia loss alone was about 480 µg/l). Because of this loss, the assay results are not reliable. However, had the loss not occurred, the expected control yield would have been a very high 158 mg/l, dry weight, of the test alga, Selenastrum capricornutum*.

D. Trophic Condition:

Survey data and the records of others show that Albert Lea Lake is highly eutrophic. Survey limnologists noted that the

* Extensive testing by EPA's Eutrophication Research and Lake Restoration Branch shows that the expected control yield of the test alga is 0.430 mg/l dry weight per µg/l of orthophosphorus or 0.038 mg/l dry weight per µg/l of inorganic nitrogen, depending on which element is limiting in the assay sample (providing something else is not limiting, of course).

lake had the appearence of "pea soup" on all sampling visits but that a particularly heavy algal bloom was occurring during the August sampling period. They also reported heavy growths of rooted aquatic vegetation.

Of the 60 Minnesota lakes on which sampling was completed, only one had a higher mean inorganic nitrogen, only four had a higher mean total and dissolved phosphorus, and none had a higher mean chlorophyll *a*.

V. NUTRIENT LOADINGS
(See Appendix C for data)

For the determination of nutrient loadings, the Minnesota National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the colder months when two samples were not obtained from the smaller streams. Sampling was begun in October, 1972, and was completed in September, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Minnesota District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings. Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were calculated using the mean concentrations in Peter Lund Creek at station C-1 and ZZ flows.

The operator of the Albert Lea wastewater treatment plant provided monthly effluent samples and corresponding flow data; however, only one sample was submitted by the Village of Clarks Grove, and nutrient loads from that source were estimated.

The loads attributed to the Wilson and Company packing plant were estimated on the basis of effluent information provided the U.S. Corps of Engineers by the Company in a September, 1972, discharge permit application (Schmiesing, 1974).

In the following tables, the loads given for tributaries do not include point-source loads.

A. Waste Sources:

1. Known municipal -

Name	Pop. Served*	Treatment	Mean Flow (mgd)	Receiving Water
Albert Lea	19,418	Act. sludge	4.337	Albert Lea Lake
Clarks Grove	480	Ponds	0.048**	ditch to Fountain Lake
Hayward	261	Pond, land disposal	0.026**	no discharge

2. Known industrial† -

Name	Product	Treatment	Mean Flow (mgd)	Receiving Water
Wilson & Company	meat packing	Secondary	0.780	Albert Lea Lake

(about 0.700 mgd of stronger wastes treated in City of Albert Lea treatment plant)

* 1970 Census.
** Estimated at 100 gal/capita/day.
† Schmiesing, 1974.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Fountain Lake outlet	9,530	6.9
Peter Lund Creek	7,950	5.8
b. Minor tributaries & immediate drainage (non-point load) -	4,030	2.9
c. Known municipal -		
Albert Lea	114,020	82.6
Clarks Grove	1,200	0.9
d. Septic tanks* -	30	<0.1
e. Known industrial -		
Wilson & Company	870	0.6
f. Direct precipitation** -	380	0.3
Total	138,010	100.0

2. Outputs -

Lake outlet - Shell Rock River 98,260

3. Net annual P accumulation - 39,750 pounds

* Estimated 360 persons/day/4 months at park and campground; see Working Paper No. 1.
** See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/ yr	% of total
a. Tributaries (non-point load) -		
Fountain Lake outlet	516,900	38.6
Peter Lund Creek	267,690	20.0
b. Minor tributaries & immediate drainage (non-point load) -	130,610	9.8
c. Known municipal -		
Albert Lea	389,480	29.1
Clarks Grove	3,600	0.3
d. Septic tanks* -	1,130	<0.1
e. Known industrial -		
Wilson & Company	5,820	0.4
f. Direct precipitation** -	23,630	1.8
Total	1,338,860	100.0

2. Outputs -

Lake outlet - Shell Rock River 848,660

3. Net annual N accumulation - 490,200 pounds

* Estimated 360 persons/day/4 months at park and campground; see Working Paper No. 1.
** See Working Paper No. 1.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	lbs P/mi^2/yr	lbs N/mi^2/yr
Fountain Lake outlet	96	5,211
Peter Lund Creek	262	8,825

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving water would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in a receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

	Total Phosphorus		Total Nitrogen	
Units	Total	Accumulated	Total	Accumulated
lbs/acre/yr	56.3	16.2	545.8	199.8
grams/m^2/yr	6.31	1.82	61.2	22.4

Vollenweider loading rates for phosphorus (g/m^2/yr) based on mean depth and mean hydraulic retention time for Albert Lea Lake:

"Dangerous" (eutrophic rate)	0.44
"Permissible" (oligotrophic rate)	0.22

VI. LITERATURE REVIEWED

Anonymous, 1962. Report on investigation of pollution of Albert Lea Lake and watershed, Freeborn County. MN Dept. of Health, Minneapolis.

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Schilling, Joel, 1974. Personal communication (map of lake; area of lake). MPCA, Minneapolis.

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VII. APPENDICES

APPENDIX A

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MINNESOTA 10/30/74

LAKE CODE 2702 ALBERT LEA LAKE

TOTAL DRAINAGE AREA OF LAKE 147.00

TRIBUTARY	SUB-DRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
2702A1	99.20	10.90	16.60	72.70	95.30	51.40	60.00	35.20	30.10	28.60	28.80	28.20	18.90	39.77
2702B1	147.00	16.30	24.90	105.10	141.40	75.20	86.80	53.00	47.10	45.30	42.60	42.70	28.90	59.17
2702C1	29.20	4.04	5.03	30.20	26.40	14.70	17.90	10.40	8.83	10.40	7.58	7.00	6.69	12.50
2702Z7	19.00	1.24	1.76	7.79	16.30	9.79	11.70	7.30	6.30	7.72	5.59	4.98	3.19	6.98

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 147.00
SUM OF SUB-DRAINAGE AREAS = 147.40

TOTAL FLOW IN = 709.97
TOTAL FLOW OUT = 709.30

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2702A1	10	72	76.30	15	37.00				
	11	72	76.70	4	176.00				
	12	72	31.30	2	37.00				
	1	73	50.30	7	24.00				
	2	73	21.30	3	24.00				
	3	73	250.00	3	295.00				
	4	73	172.00	8	57.00				
	5	73	216.00	19	69.00				
	6	73	24.60	3	64.00				
	7	73	85.90	14	28.00				
	8	73	54.50	11	47.00				
	9	73	135.00	15	46.00				
2702B1	10	72	115.00	15	55.00				
	11	72	118.00	4	270.00				
	12	72	48.60	2	58.00				
	1	73	76.50	7	38.00				
	2	73	32.40	3	37.00				
	3	73	368.00	3	434.00				
	4	73	259.00	8	86.00				
	5	73	322.00	19	103.00				
	6	73	36.20	3	102.00				
	7	73	132.00	14	42.00				
	8	73	88.30	11	77.00				
	9	73	217.00	15	74.00				

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TRIBUTARY FLOW INFORMATION FOR MINNESOTA 10/30/74

LAKE CODE 2702 ALBERT LEA LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2702C1	10	72	20.10	15	96.00				
	11	72	19.00	4	44.00				
	12	72	11.10	2	13.00				
	1	73	18.80	7	9.00				
	2	73	6.44	3	7.40				
	3	73	104.00	3	123.00				
	4	73	47.50	8	16.00				
	5	73	61.90	19	20.00				
	6	73	7.34	3	21.00				
	7	73	26.40	14	8.50				
	8	73	15.90	11	14.00				
	9	73	48.90	15	17.00				
2702Z7	10	72	14.80	15	7.10				
	11	72	13.50	4	31.00				
	12	72	5.27	2	6.30				
	1	73	5.72	7	2.80				
	2	73	2.25	3	2.60				
	3	73	26.80	3	32.00				
	4	73	29.30	8	9.70				
	5	73	41.20	19	13.00				
	6	73	4.80	3	14.00				
	7	73	17.80	14	5.70				
	8	73	11.40	11	9.90				
	9	73	36.40	15	12.00				

APPENDIX B

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/10/30

270201
43 3H 42.0 093 20 51.0
ALHERT LEA LAKE
27 MINNESOTA

11E*ALES
3

2111202
0002 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/01	09 30 0000		24.5	13.6	6	750	9.20	180	0.530	0.850	0.958	0.780
72/08/30	00 00 0000							204	0.260	1.120	1.260	0.685
	14 00 0000		22.0	12.8	4	680	8.70					
72/10/29	13 35 0000		7.8	14.0	12	825	8.50	200	0.670	0.170	2.080	1.700

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/01	09 30 0000		478.4J
72/08/30	14 00 0000		510.2J
72/10/29	13 35 0000		177.3J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/10/10

270202
43 37 06.0 093 18 27.0
ALBERT LEA LAKE
27 MINNESOTA

11EPALES
3

2111202
0002 FEET DEPTH

DATE FROM TO	TIME	DEPTH OF DAY	FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/01	09	50	0000	24.1	7.2	6	570	9.10	132	0.110	0.120	0.916	0.698
72/08/30	14	35	0000	21.6	11.4	5	590	9.13	184	0.180	0.410	1.080	0.504
72/10/29	13	45	0000	7.5	11.1	12	725	8.50	208	0.660	2.600	1.380	1.060

22

DATE FROM TO	TIME	DEPTH OF DAY	FEET	32217 CHLOPHYL A UG/L
72/07/01	09	50	0000	513.1J
72/08/31	14	35	0000	245.6J
72/11/29	13	45	0000	165.5J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/10/10

270203
43 38 27.0 093 16 54.0
ALBERT LEA LAKE
27 MINNESOTA

11EPALES
3

2111202
0002 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/01	10 00	0000	25.0	11.0	6	470	9.40	93	0.060	0.030	0.029	0.016
72/08/30	14 50	0000	21.[illegible]	8.6	3	500	8.70	159	0.170	0.220	0.955	0.234
72/10/29	13 55	0000	7.[illegible]	17.0	12	750	8.40	238	8.300	0.140	0.363	0.048

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/01	10 00	0000	452.1J
72/08/30	14 50	0000	756.0J
72/10/29	13 55	0000	152.6J

J VALUE KNOWN TO BE IN ERROR

APPENDIX C

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 74/10/30

2702A1 LS2702A1
43 39 00.0 093 21 30.0
ALBERT LEA / FOUNTAIN LAKE COMN.
27085 15 ALBERT LEA
I/ALBERT LEA LAKE
US 69 BRDG IN ALBERT LEA
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/15	08 45		0.104	2.520	0.069	0.016	0.168
72/11/04	15 00		2.000	1.945	0.230	0.026	0.138
72/12/02	14 40		4.800	1.520	0.024	0.008	0.066
73/01/07	11 25		4.900	2.000	0.285	0.041	0.075
73/02/03	16 30		6.600	2.700	0.610	0.180	0.223
73/03/03	16 05		4.900	4.000	1.200	0.600	0.720
73/04/08	09 45		7.200	2.000	0.028	0.012	0.095
73/05/19	16 00		8.250	2.000	0.010	0.009	0.080
73/06/03	12 00		6.100	2.500	0.018	0.014	0.115
73/07/14	17 50		3.300	2.520	0.024	0.018	0.150
73/08/11	17 45		0.110	3.100	0.024	0.021	0.155
73/09/15	15 30		0.021	2.250	0.046	0.028	0.180

STORET RETRIEVAL DATE 74/10/30

270281 LS270281
43 37 00.0 093 17 30.0
SHELL ROCK RIVER
27 15 ALBERT LEA
0/ALBERT LEA LAKE
CO HWY 19 SE END OF LAKE
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/15	16 15		0.220	6.400	0.520	0.120	0.360
72/11/04	15 20		0.655	4.275	0.530	0.058	0.790
72/12/02	15 15		1.570	3.900	0.650	0.930	1.020
73/01/07	10 50		0.440	6.400	4.500	1.890	1.900
73/02/03	16 15		2.000	8.300	6.200	2.100	2.100
73/03/03	16 20		3.900	2.400	1.300	0.370	0.430
73/04/08	11 00		5.800	4.300	0.180	0.130	0.420
73/05/19	17 50		4.900	4.100	0.014	0.032	0.270
73/06/03	11 00		1.120	5.200	0.044	0.056	0.345
73/07/14	15 25		0.024	6.800	0.048	0.320	0.750
73/08/11	15 45		0.010K	6.400	0.044	0.189	0.590
73/09/15	18 05		0.010K	6.000	0.034	0.176	0.575

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/10/30

2702C1 LS2702C1
43 38 30.0 093 16 00.0
PETER LUND CR
27 15 ALBERT LEA
T/ALBERT LEA
CO HWY 98 BRDG 1 MI W HAYWARD
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/15	09 35		6.400	0.960	0.038	0.115	0.154
72/11/04	15 35		4.340	0.100K		0.098	0.126
72/12/02	13 25		9.100	0.100K	0.075	0.072	0.092
73/03/03	16 38		4.100	5.200	1.600	0.860	1.080
73/04/04	10 45		15.000	1.100	0.058	0.050	0.070
73/05/19	17 35		15.000	1.150	0.075	0.065	0.155
73/06/03	11 05		14.000	0.820	0.102	0.100	0.180
73/07/14	13 50		7.600	1.900	0.018	0.128	0.250
73/08/11	16 00		5.100	3.100	0.170	0.230	0.390
73/09/15	17 45		3.400	1.380	0.052	0.440	0.525

K VALUE KNOWN TO BE LESS
THAN INDICATED

STORET RETRIEVAL DATE 74/10/10

270201 LS270201
43 45 00.0 093 19 30.0
UNNAMED STREAM
27 7.5 ELLENDALE
T/ALBERT LEA LAKE
DIRT ROAD XING E CLARKS GROVE
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/15	10 35		0.073	1.550	0.088	0.210	0.300
72/11/04	14 20		0.052	0.147	0.147	0.290	1.035
73/02/03	17 40		0.080	6.200	1.890	0.040	1.930
73/04/08	10 25		0.063	2.150	0.160	1.000	1.350
73/05/19	14 45		0.026	2.100	0.021	1.050	1.350
73/06/03	11 35		0.066	1.890	0.086	0.620	1.300
73/07/14	17 20		0.360	4.800	1.950	0.078	1.300
73/08/11	17 15		0.154	5.100	2.000	0.062	2.600
73/09/15	14 45		0.610	5.500	1.470	0.052	1.000

STORET RETRIEVAL DATE 74/10/30

270251 AS270251 P019418
43 38 30.0 093 21 30.0
ALHERT LEA
27085 IS ALHERT LEA
0/ALHERT LEA LAKE
ALHERT LEA LAKE
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO3&NO2 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/01/17	04	00							
CP(T)-			0.060	23.000	10.000	6.400	9.735	4.620	3.790
73/01/18	08	00							
73/02/04	04	30							
CP(T)-			0.020	34.000	29.400	11.100	12.600	4.670	3.800
73/02/04	08	30							
73/03/05	08	00	0.050	33.600	22.000	7.800	8.300	4.640	3.870
73/04/15	04	30							
CP(T)-			1.600	28.400	14.700	5.100	6.200	7.200	5.300
73/04/16	08	30							
73/05/10	08	00	0.910	13.400	2.800	3.500	4.200	7.000	6.200
73/06/19	11	00							
CP(T)-			15.000	0.100K	0.009	5.400	6.100		
73/06/19	13	00							
73/06/27	08	00	0.312	24.100	11.200	6.720	8.200	5.270	5.110
73/07/23	08	00	0.000	39.000	16.000	7.700	8.600	3.380	4.150
73/08/27	04	00							
CP(T)-				24.700	12.100	6.700	9.200	4.330	3.890
73/08/28	08	00							
73/09/20	08	00							
CP(T)-			1.520	23.600	15.400	3.360	8.900	4.700	4.160
73/09/21	08	00							
73/10/09	04	00							
CP(T)-			2.000	36.000	17.500	2.400	7.700	6.500	4.750
73/10/10	08	00							
73/11/10	08	00							
CP(T)-			0.230	45.000	31.000	2.400	12.000	4.600	4.710
73/11/12	08	00							
73/12/04	08	00							
CP(T)-			0.840	16.300	4.200	2.100	7.500	2.250	3.300
73/12/09	08	00							
74/01/05	12	00							
CP(T)-			0.120	40.000	30.000	12.600	14.800	3.360	3.350
74/01/06	12	00							

K VALUE KNOWN TO BE LESS THAN INDICATED

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